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43. (Amended) The semiconductor device package of claim 42 wherein the strips of compliant adhesive film are positioned substantially parallel with a longitude of the semiconductor die.

REMARKS

Claims 1-18 and 38-49 are pending in the present application. Claims 46-49 are cancelled by the present amendment without prejudice to pursue the cancelled claims in a divisional application. Claims 1-8, 10-18, 38-39, and 41 have been rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 6,169,328 to Mitchell *et al.* ("Mitchell"). Claims 9, 40, and 42-45 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over Mitchell in light of U.S. Patent No. 5,891,566 to Sakumoto *et al.* ("Sakumoto").

In order to help the Examiner appreciate certain distinctions between the pending claims and the subject matter of the applied references, the disclosed embodiment of the invention will now be discussed in comparison to the applied references. Specific distinctions between the pending claims and the applied references will be discussed after the discussion of the disclosed embodiment and the applied references. This discussion of the differences between the disclosed embodiment and applied references does not define the scope or interpretation of any of the claims.

Embodiments of the present invention are directed to a semiconductor package assembly having a plurality of pieces of compliant adhesive film to adhere a semiconductor die to an interposer to reduce failures in solder bonds caused by shearing forces resulting from unmatched thermal expansion rates of the interposer and the semiconductor die. The compliant quality of the adhesive film prevents the film from shearing when the die and substrate expand at uneven rates, while minimizing lateral shifting of the substrate and die during heating. The specification further describes that the cumulative thermal expansion for the multiple pieces of adhesive film is less than the thermal expansion for a single layer of elastomer material. As a

result, stress on wire bond joints resulting from the different coefficients of thermal expansion between the die and the substrate are reduced.

The plurality of pieces of compliant adhesive film are improvements over package assemblies employing elastomer posts mounted onto a substrate or die. Elastomer post assemblies require expensive equipment and time-consuming treatments to prevent height differences in the elastomer posts from altering the coplanarity of the die and substrate. Such height differences can render a package assembly unacceptable, and thus decrease yield. As explained in the specification, the plurality of pieces of film in a package assembly reduces the need for precision processing to ensure coplanarity since the film is essentially uniform in height.

Rejections Under 35 U.S.C. § 102(e)

Claims 1-8, 10-18, 38-39, and 41 are rejected under 35 U.S.C. § 102(e) as being anticipated by Mitchell. The Mitchell patent describes a semiconductor chip assembly wherein viscous elastomer material is screen-printed onto a substrate and cured to form an array of elastomer posts. Mitchell further teaches applying a wet or dry attach adhesive to the end of the cured elastomer in order to attach the die or substrate to the elastomer posts. In addition, Mitchell teaches an alternate method of attaching the elastomer post array whereby the posts are formed within a holder and the holder/post assembly is subsequently attached to the die or substrate. Numerous assembly steps are required to screen-print the viscous elastomer material onto the flexible substrate, to cure the viscous material, and to apply the dry adhesive to the resulting elastomer post. (Col. 5, line 26 to col. 6, line 50). As a result, the numerous and time-consuming screening and curing steps required to form the elastomer array decrease product throughput at the assembly stage. Also, coplanarity of the substrate and die may be compromised when elastomer posts of unequal height are disposed between the die and substrate.

Turning now to the claims, amended claim 1 recites a semiconductor device package where the semiconductor die is attached to an interposer by a plurality of pieces of compliant adhesive film disposed in between the semiconductor die and the interposer. The Mitchell patent, however, teaches an elastomer post array that is screen-printed or formed within a holder and subsequently attached to the die or substrate. Mitchell further explains that the

resultant elastomer post array may not be of uniform height due to limitations in the post-formation process. (Fig. 1, els. 110, 115). Thus, the elastomer post array described in Mitchell is distinguishable from the plurality of pieces of compliant adhesive film recited in amended claim 1. As such, the rejection of claim 1 under 35 U.S.C. 102(e) should be withdrawn.

Claim 2 recites, in addition to a plurality of pieces of compliant adhesive film, an encapsulating material substantially filling remaining regions between the die and the interposer. Claim 3 further recites a flexible interposer. Claims 2 and 3, moreover, which depend from claim 1, further limit claim 1 from which they depend. Thus, the rejections of claims 2 and 3 under 35 U.S.C. § 102(e) should be withdrawn.

Amended claim 5 recites that the compliant adhesive film is comprised of a compliant carrier disposed between two adhesive layers. The adhesive layers are further attached to an interposer and die respectively. In Mitchell, the elastomer post array is placed onto the die or substrate surface by way of a holding device, which is taken away after the array is adhered to the surface. Mitchell further teaches that an adhesive may be applied to the elastomer post array to make them tacky enough to adhere to the die or substrate. In the alternative, Mitchell teaches that the adhesive may be applied to the surfaces themselves to adhere the array of posts once they are placed in contact with the surfaces. Thus, the compliant adhesive film recited in claim 5 is distinguishable from the elastomer post array disclosed in Mitchell. Moreover, amended claim 5, which depends from amended claim 1, is patentable because it further limits patentable claim 1. As such, the rejection of claim 5 under 35 U.S.C. § 102(e) should be withdrawn.

Amended claim 6 recites that the plurality of pieces of compliant adhesive film comprises a single layer of elastomer material. As previously discussed, Mitchell does not teach a using film, but instead teaches elastomer posts binding the die and substrate together in a package assembly. Amended claim 6, on the other hand, recites compliant adhesive film comprised of an elastomer material. Amended claim 6 is further patentable because it further limits patentable claim 1. Thus, the rejection of claim 6 under 35 U.S.C. § 102(e) should be withdrawn.

Amended claim 7 recites a semiconductor package assembly wherein a first surface of the semiconductor die is adhered to the die attach surface of the substrate by the

plurality of pieces of compliant adhesive film. The Mitchell patent, however, discloses a semiconductor die attached to a substrate by an array of elastomer posts. As previously explained, the elastomer posts disclosed in Mitchell are distinguishable from pieces of compliant adhesive film. Amended claim 7 is also patentable because it depends from, and further limits, patentable amended claim 1. As such, the rejection of claim 7 under 35 U.S.C. § 102(e) should be withdrawn.

Amended claim 10 recites a semiconductor package assembly having a first and a second of the plurality of pieces of compliant adhesive film positioned at a right angle with respect to one another. The examiner cited Figure 9 in support of the proposition that the Mitchell patent discloses pieces of adhesive film positioned at a right angle with respect to one another. Figure 9, however, shows elastomer posts—not film. Furthermore, the posts 620 shown in Figure 9 are not at right angles with respect to one another. In fact, there is no angle between them at all. In addition, Amended claim 10 further limits patentable amended claim 1, from which it depends. Thus, the rejection of claim 10 under 35 U.S.C. § 102(e) should be withdrawn.

Amended claim 11 recites a device package assembly for a semiconductor die being constructed from a process that includes laminating a plurality of pieces of compliant adhesive film to an interposer. Mitchell discloses screen-printing an array of elastomer posts to an interposer, or forming the posts within a holder and affixing the posts to a die or substrate with an adhesive. Thus, the rejection of claim 11 under 35 U.S.C. § 102(e) should be withdrawn given that Mitchell does not disclose laminating film onto an interposer.

Claims 12-15, which depend from patentable amended claim 11, further limit patentable amended claim 11 from which they depend. Claim 12 recites filling regions remaining in between the die and the interposer with encapsulating material. Claim 13 recites attaching at least one external terminal of patentable amended claim 11 to at least one electrically conductive interconnect adjacent to the external surface of the interposer. Claim 14 depends from patentable claim 13, and further recites that the interposer comprises a flexible material. Claim 15 recites the patentable device package assembly of amended claim 11 where the interposer comprises a flexible material. Therefore, the rejection of claims 12-15 under 35 U.S.C. § 102(e) should be withdrawn.

Amended claim 17 recites a plurality of pieces of compliant adhesive film comprising a single layer of elastomer material. As previously explained, Mitchell does not disclose compliant adhesive film comprised of elastomer material, but instead discloses an array of elastomer posts. Amended claim 17 is also patentable through its dependence on patentable amended claim 11, and because it further limits patentable amended claim 11. Thus, the rejection of claim 17 under 35 U.S.C. § 102(e) should be withdrawn.

Amended claim 18 recites the plurality of pieces of compliant adhesive film of amended claim 11 positioned in parallel along a longitude of the semiconductor die. Mitchell does not disclose film, much less strips of compliant adhesive film positioned in parallel along a longitude of the semiconductor die. Moreover, the examiner did not cite to Mitchell in support of the proposition that Mitchell discloses such an element. Amended claim 18 is further patentable through its dependence on, and further limitation of, patentable amended claim 11. As such, the rejection of claim 18 under 35 U.S.C. § 102(e) should be withdrawn.

Claim 38 recites, in pertinent part, a semiconductor device package comprising a plurality of pieces of compliant adhesive film interposed between the die attach surface and the semiconductor die to adhere the semiconductor die to the die attach surface of the interposer. As previously described in detail, Mitchell discloses an array of elastomer posts as opposed to a plurality of pieces of compliant adhesive film. Thus, the rejection of claim 38 under 35 U.S.C. § 102(e) should be withdrawn.

Claim 39 recites the pieces of compliant adhesive film comprising an elastomer material. Mitchell discloses an array of elastomer posts, as opposed to a plurality of pieces of film. Claim 39, which depends from patentable claim 38, further narrows patentable claim 38 from which it depends. Therefore, the rejection of claim 39 under 35 U.S.C. § 102(e) should be withdrawn.

Claim 41 recites, in pertinent part, an external conductive terminal electrically coupled to the electrically conductive interconnect of the interposer and positioned on a surface of the interposer opposite of the die attach surface. Claim 41, which depends from patentable claim 38, further limits patentable claim 38 from which it depends. Therefore, the rejection of claim 41 under 35 U.S.C. § 102(e) should be withdrawn.

Rejections Under 35 U.S.C. § 103(a)

Claims 9, 40, and 42-45 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over Mitchell in view of Sakumoto. Not only is there no motivation or suggestion to combine the references, but once the references are combined they do not teach or suggest the semiconductor package assemblies recited in claims 9, 40 and 42-45.

Sakumoto discloses adhesive tapes suitable for fixing leadframe leads in place prior to wire bonding, and preventing the leads from spreading apart when the leadframe is heated or cooled. When the leadframe is heated and the leads drift apart, wire bonding is hampered because the leads may no longer be situated over the bond pads of the semiconductor die. The tape disclosed in Sakumoto, moreover, necessarily has a low coefficient of thermal expansion to prevent the tape itself from spreading along with the leads. Thus, a compliant film would be unsuitable for ensuring that the leads not drift apart during thermal expansion of the leadframe. The disclosed invention, by way of contrast, employs compliant adhesive film disposed between an interposer and semiconductor die to prevent the film from shearing during thermal expansion of the die and substrate. Sakumoto, on the other hand, does not disclose tape bonded to anything but the leadframe leads, nor does Sakumoto teach tape binding the leads to any other component of a semiconductor package assembly.

Combining Sakumoto with Mitchell does not make up for the deficiencies of the Mitchell and Sakumoto patents as previously described. In particular, Mitchell does not teach a plurality of pieces of compliant adhesive film disposed between a substrate and a semiconductor die, and teaches instead that an array of elastomer posts may be used to bind a die to a substrate. Sakumoto teaches that tape having a minimal coefficient of thermal expansion may be used to hold leadframe leads in place to prevent them from spreading when a leadframe expands. As previously mentioned, Sakumoto neither teaches nor suggests that the tape disclosed therein may be used to bind the leads to any other part of the semiconductor assembly. In fact, it would appear that the tape is left behind on the leadframe once the leads are bonded to the semiconductor device and the package is punched out of the leadframe. Indeed, nowhere does Sakumoto patent teach that the tape becomes integral to the semiconductor package, nor does Sakumoto suggest that the tape is suitable for inclusion within the package assembly at all. The fact that Sakumoto teaches a tape having a minimal coefficient of thermal expansion further

suggests that the tape would not be suitable for inclusion within a package assembly requiring a compliant material to accommodate thermal mismatch. Mitchell similarly fails to teach or suggest that film of any sort may be used to bind the die and substrate together and accommodate thermal mismatch.

Amended claim 9, which depends from patentable amended claim 1, recites a plurality of pieces of compliant adhesive film positioned in parallel along a longitude of the semiconductor die. As previously mentioned, Mitchell does not teach compliant adhesive film, and teaches instead elastomer posts screened or placed onto a die or interposer. Nor does Mitchell teach or suggest that film may be used to adhere the interposer to the die as opposed to the elastomer post array disclosed therein. Sakumoto does not teach or suggest that the disclosed tape can be used within a semiconductor package assembly nor does it teach that the disclosed tape is compliant. Thus, the rejection of claim 9 under 35 U.S.C. § 103(a) should be withdrawn.

Claim 40 depends from patentable claim 38, and further recites a plurality of pieces of compliant adhesive film positioned in parallel along a longitude of the semiconductor die. As explained with respect to amended claim 9, Mitchell does not teach compliant adhesive film, and teaches instead elastomer posts screened or placed onto a die or interposer. Furthermore, Mitchell does not teach or suggest that film, as opposed to the elastomer post array, may be used to adhere an interposer to a die. Sakumoto does not teach or suggest that the disclosed tape can be used within a semiconductor package assembly nor does it teach or suggest that the disclosed tape is or can be compliant. Thus, the rejection of claim 40 under 35 U.S.C. § 103(a) should be withdrawn.

Amended claim 42 recites, in pertinent part, a semiconductor device package assembly having a plurality of strips of compliant adhesive film interposed between the die attach surface and the semiconductor die to adhere the semiconductor die to the die attach surface to the interposer. As previously explained, Mitchell does not teach or suggest a plurality of strips of compliant adhesive film adhering the semiconductor die to the die attach surface of the interposer. Moreover, Sakumoto does not teach or suggest that the disclosed tape is suitable for use within a semiconductor package assembly, nor does Sakumoto teach or suggest that the disclosed tape is compliant such that it may accommodate expansion within the package caused

by thermal mismatch. Thus, the rejection of claim 42 under 35 U.S.C. § 103(a) should be withdrawn.

Amended claim 43 recites a semiconductor device package having strips of compliant adhesive film positioned substantially parallel with a longitude of the semiconductor die. Amended claim 43 is similarly patentable through its dependence on patentable claim 42, and because it further limits claim 42. As previously discussed in detail, Mitchell does not disclose film and Sakumoto does not disclose compliant adhesive film to prevent shearing caused by uneven expansion. Indeed, the tape in Sakumoto is intended to be non-compliant in order to maintain the leadframe leads in place when the leadframe expands during heating. In addition, Sakumoto does not teach or suggest that the disclosed tape may be suitable to adhere elements of a semiconductor device package together. Thus, combining Sakumoto with Mitchell does not compensate for the deficiencies of Mitchell as previously described, and the rejection of amended claim 43 under 35 U.S.C. § 103(a) should be withdrawn.

Claims 44 further limits patentable claim 42 from which it depends. Claim 44 recites the semiconductor device of patentable amended claim 42 wherein a first and second strip of the plurality are positioned substantially at a right angle with respect to each other. As previously discussed in detail, Mitchell does not disclose film and Sakumoto does not disclose compliant adhesive film adhering one component of the package assembly to another to prevent shearing caused by uneven expansion. Thus, combining Sakumoto with Mitchell does not compensate for the deficiencies of Mitchell as previously described, and the rejection of amended claim 44 under 35 U.S.C. § 103(a) should be withdrawn.

Claim 45 recites the semiconductor device of patentable amended claim 42 wherein at least one of the plurality of strips comprises a compliant layer and at least one adhesive layer adhered to the compliant layer. Mitchell does not disclose film, and Sakumoto does not disclose at least one adhesive layer adhered to the compliant layer. While Sakumoto does disclose a carrier layer having adhesive layers on both sides, Sakumoto does not teach or suggest that the carrier layer can be comprised of a compliant layer. As previously discussed, a compliant layer would seem unsuitable for tape that is intended to prevent leads from shifting during heat expansion. Thus, combining Sakumoto with Mitchell does not compensate for the

deficiencies of Mitchell as previously described, and the rejection of amended claim 45 under 35 U.S.C. § 103(a) should be withdrawn.

Attached hereto is a marked-up version of the changes made to the claims by the current amendment. The attached page is captioned "Version with Markings to Show Changes Made".

All of the claims remaining in the application are now clearly allowable. Favorable consideration and a Notice of Allowance are earnestly solicited.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

1. (Amended) A semiconductor device package, comprising:
 - a semiconductor die having a first surface on which an integrated circuit and at least one electrically conductive bond pad are fabricated;
 - at least one electrically conductive external terminal;
 - an interposer having a die attach surface and an external surface opposite of the die attach surface disposed in between the semiconductor die and the at least one external terminal, the interposer having at least one electrically conductive interconnect electrically coupling the at least one bond pad of the semiconductor die positioned adjacent to the die attach surface to the at least external terminal positioned adjacent to the external surface; and
 - a plurality of pieces of compliant adhesive film disposed in between the semiconductor die and the interposer to adhere the semiconductor die to the die attach surface of the interposer.
5. (Amended) The package of claim 1 wherein each of the plurality of pieces of compliant adhesive film comprises:
 - a first adhesive layer adhered to the die attach surface of the interposer;
 - a second adhesive layer adhered to the semiconductor die; and
 - at least one compliant carrier layer disposed in between the first and second adhesive layers and to which the first and second adhesive layers are adhered.
6. (Amended) The package of claim 1 wherein each of the plurality of pieces of compliant adhesive film comprises a single layer of elastomer material.
7. (Amended) The package of claim 1 wherein the first surface of the semiconductor die is adhered to the die attach surface of the interposer by the plurality of pieces of compliant adhesive film.

9. (Amended) The package of claim 1 wherein the plurality of pieces of compliant adhesive film comprise strips of compliant adhesive film positioned in parallel along a longitude of the semiconductor die.

10. (Amended) The package of claim 1 wherein a first and a second of the plurality of pieces of compliant adhesive film are positioned at a right angle with respect to each other.

11. (Amended) A device package assembly for a semiconductor die being constructed from a process comprising:

laminating a plurality of pieces of compliant adhesive film to an interposer having at least one electrically conductive interconnect, the interposer further having a die attach surface to which the semiconductor die is attached, and an external surface opposite of the die attach surface;

attaching to the interposer the semiconductor die having a first surface on which an integrated circuit and at least one electrically conductive bond pad are fabricated; and

bonding the at least one electrically conductive interconnect to the at least one electrically conductive bond pad.

17. (Amended) The package assembly of claim 11 wherein each of the plurality of pieces of compliant adhesive film comprises a single layer of elastomer material.

18. (Amended) The package assembly of claim 11 wherein the plurality of pieces of compliant adhesive film comprise strips of film positioned in parallel along a longitude of the semiconductor die.

42. (Amended) A semiconductor device package, comprising:
a semiconductor die having a first surface on which at least one electrically conductive bond pad is fabricated;

an interposer having a die attach surface and at least one electrically conductive interconnect electrically coupled to at least one bond pad of the semiconductor die; and

a plurality of strips of compliant adhesive film interposed between the die attach surface and the semiconductor die to adhere the semiconductor die to the die attach surface of the interposer.

43. (Amended) The semiconductor device package of claim 42 wherein the strips of compliant adhesive film are positioned substantially parallel with a longitude of the semiconductor die.